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Assessing digital competence and its impact on academic performance: insights from Universiti Malaysia Sarawak undergraduates

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ABSTRACT

Information and communication technology (ICT) has become an essential part of the daily lives of tertiary students. However, research into assessing digital competency and its effects on academic performance is still limited. This paper explores students' needs for digital competence, the impact of digital access on academic performance, and the relationship between digital competence and educational success, focusing on undergraduates at Universiti Malaysia Sarawak (UNIMAS). Using a model with 64 measurement items and nine variables, the study identifies significant correlations between information and data literacy (IDL), safety and security (SS), and problem-solving (PS) proficiency with digital competence. Conversely, communication and collaboration (CC) and digital content creation (DCC) show statistically insignificant correlations. Additionally, while digital resource availability has a minor inverse correlation, digital usage is significantly and positively related to digital competence. The findings suggest that digital competence strongly predicts academic performance and that most undergraduates exhibit advanced proficiency in essential digital skills. This research highlights the crucial role of digital competence in enhancing educational outcomes and offers insights into key competencies linked to digital effectiveness.

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1. INTRODUCTION

The need for digitally competent citizens has become paramount in today's digital society. Achieving digital competence involves using information and communication technology (ICT) easily and securely for activities like learning, working, shopping, job-seeking, and accessing health information, as almost every aspect of human activities, including education, relies on or is supported by ICT. Obrenovic *et al.* [1], ICT initiatives increase capacity, productivity, and efficiency at a particular task or operation. In addition, ICT has the potential to enhance accuracy and provide quick and reliable outcomes in any area of application.

Anastasopoulou *et al*. [2] suggests that effective ICT adoption boosts student motivation, and understanding and supports lifelong learning by facilitating interactive teaching methods, personalized learning experiences, and self-directed learning opportunities. ICT integration in education allows students to learn from any location and at any time. However, successful ICT adoption requires consideration of the specific digital competencies and practical skills needed for different educational levels and fields. For instance, Algarni *et al*. [3] found that virtual reality simulations in dental education improve learning outcomes, demonstrating that virtual education can enhance performance through structured training and technical proficiency. Students can advance their learning with the appropriate digital tools and guidance regardless of their field of study.

The motivation for this study stems from the impact of the COVID-19 pandemic lockdown on higher education and the ongoing digitalization in the education sector. ICT has become integral to teaching, assessment, and administrative processes in education. Students' adept at utilizing digital resources for research, collaboration, and presentation may have an advantage over those less skilled. Previously, as a supplementary tool, digital has since become the primary method of instruction and learning, making it crucial to assess students' digital competence. Despite most higher education students being Millennials or Gen Z, often viewed as digital natives, research by Adedoyin and Soykan [4] and Martín *et al*. [5] reveals that many students still lack the anticipated digital skills. Therefore, thoroughly evaluating the digital competencies required for tertiary studies is crucial. Evaluating digital competencies may involve assessing students' ability to navigate digital platforms, use software for academic tasks (e.g., word processing, data analysis), critically evaluate online information, and engage in effective digital communication tailored to their field of study requirements.

Most digital competence research focused on the teacher [6]–[8], with little work on learners' digital competence. Teachers have been viewed as critical enablers in improving learners' digital literacy and performance. Furthermore, no effective measures are implemented to monitor individual learners' digital competence [9]. The available measures have shortcomings, including incompleteness, oversimplification, conceptual ambiguity, self-reporting, generalization ability, locality-based measures, overlaps, and cross-references across areas of competencies [10], [11].

This paper reports on a survey conducted on undergraduate students at Universiti Malaysia Sarawak (UNIMAS) to assess their proficiency levels in various areas of digital competence. This study aimed to identify students' digital competence needs, assess the impact of digital access (encompassing both the availability of digital resources and their usage) on student performance, and investigate the relationship between digital competence and academic performance.

Competency-based education is currently receiving significantly increased attention. However, competency-based education's creation, assessment, and implementation differ across educational systems. According to the European Commission, digital competence is one of the eight core lifelong learning competencies. The European Digital Competence (DigComp) platform provides a comprehensive and systematic framework for people that can be tailored to specific target groups' needs [12]. Digital competency involves the necessary knowledge, skills, and attitudes for effectively using digital technologies to navigate, understand, communicate, create, and critically evaluate information across various contexts. According to Caena and Redecker [6] and Falloon [7] the European ICT framework recognizes the effective use of technology as an essential competence all citizens need. Figure 1 illustrates ICT's evolving trend and application in education over time. As the number of virtual educational programs increases, institutions demand that students become proficient with various digital tools. Students use ICT for socializing, collaborating, and communicating.

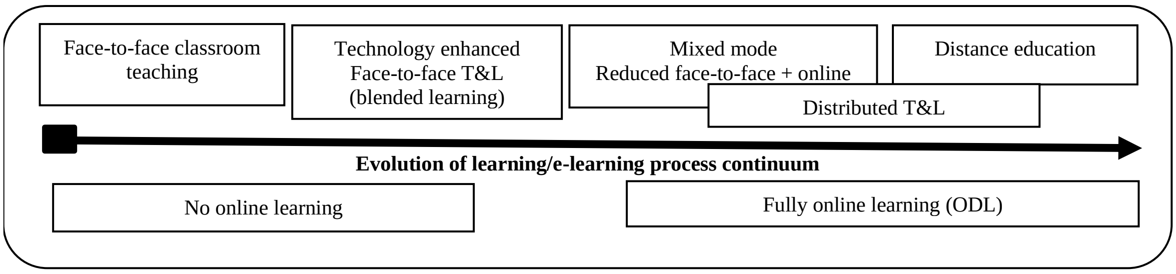

Figure 1. Phases of technology (digital) application in teaching and learning

The Malaysian Ministry of Education (MOE) has developed a strategy to improve the country's education standards through the integration of ICT, as outlined in the Malaysian Education Blueprint 2013-2025. This blueprint emphasizes incorporating technology-based teaching and learning into the national curriculum. Consequently, the modern educational system requires teachers and students to develop specific digital competencies to explore and utilize information in school effectively. However, the successful application of technology in education hinges on a deep understanding and confidence in its use, regardless of how advanced it may be.

The study by [13], [14] emphasizes that as technology becomes increasingly prevalent in the workforce and educational settings, students must become adept with various digital applications. This shift from a teacher-centered to a student-centered approach in education highlights the importance of implementing effective ICT measures in schools. Teachers are crucial in guiding students through the diverse ICT applications and their functionalities, ensuring they do not become overwhelmed [15]. As stated by Miranda *et al.* [16], user competence and effective pedagogical methods for using ICT are essential for realizing its full impact on education.

Literature presents varied findings on the impact of digital competency on academic performance. Núñez-Canal *et al*. [17] previously found that digital competency does not significantly affect academic achievement in practical settings. Recent studies suggest that digital competency is crucial for enhancing academic performance by boosting research efficiency and productivity among university students, which leads to improved outcomes and innovation in higher education institutions [18]‒[20]. This shift may be attributed to experiences during the COVID-19 pandemic. In other research, Ibrahim and Aldawsari [21] found that the direct effect of digital capabilities on student performance remained significant even when accounting for the mediator, which in this study was self-efficacy.

Access to digital resources such as computers, the internet, and relevant software is crucial for academic success in the digital age. Disparities in access can create inequalities in educational outcomes. Assessing digital access involves understanding factors such as the availability of hardware (e.g., computers, tablets), reliable internet connection, and access to educational software and platforms both at school and at home. Digital access in this study refer to availability of digital resources and digital usage, which is believed to impact student academic performance. In many countries, students have access to standard ICT resources, both at home and in school. In addition, student's access to the Internet and computers has expanded rapidly [22]. However, the usage of digital resources (digital usage) is more important than the quantity and quality of technology available [23].

In conclusion, students with higher digital competencies are likely to show improved research skills, critical thinking, and presentation abilities, all of which can enhance their academic performance. However, it remains unclear what level of digital competency is necessary for students to excel academically or if this requirement varies by field of study. On the other hand, students with limited digital access may struggle with completing assignments, accessing online resources, or engaging in digital learning activities, potentially hindering their academic success. Given the pivotal role of ICT in education, assessing students' digital competence is crucial for effectively supporting their learning outcomes. Fostering and developing digital competency is vital for promoting sustainable educational advancement and comprehensive student development.

2. METHODOLOGY

It is crucial to acknowledge that the ICT requirements of various industries vary. Likewise, the level of proficiency needed by an individual varies as well. The focus of this research is to assess the digital competences, access, and understanding their impact on the academic performance of undergraduate students from ten different faculties at UNIMAS. The sample pool encompasses both local and international students. To gather primary data, a well-structured online questionnaire was utilized. The instrument comprised of items adapted from established instruments from the literature. The composition of the questionnaire designed for this study is presented in Table 1.

Table 1. Type and number of questions in the questionnaire

No	Type of questions	No of measuring items (indicator)
1	Demographic	7
2	Information and data literacy (IDL)	5
3	Communication and collaboration (CC)	5
4	Digital content creation (DCC)	5
5	Security and safety (SS)	5
6	Problem-solving (PS)	5
7	Digital usage	8
8	Availability of digital resources (IRF)	10
9	Digital competence (Dig_Comp)	12
10	Student performance (SP)	9

In this study, the research model was based on the DigComp 2.1 framework, which assesses the digital competence of citizens across eight proficiency levels. These levels range from foundational, scored as 1, to highly specialized, scored as 8, as outlined by [10]. This study does not require undergraduate students to possess highly specialized digital competencies. Instead, proficiency levels 1 to 6 (foundation, intermediate, and advanced) will be sufficient for the purpose of this research, refer to Table 2.

Table 2. Digital competency level for variable measurement

Six proficiency level	Level	Score
At basic level and with guidance, I can	Foundation	1
At basic level and with autonomy and appropriate guidance where needed, I can	(simple task)	2
On my own and solving straightforward problems, I can	Intermediate	3
Independently, according to my own needs, and solving well-defined and non-routine problems, I can		4
As well as guiding others, I can	Advance	5
At advanced level, according to my own needs and those of others, and in complex contexts, I can		6

The questionnaire was distributed online to 218 respondents pursuing bachelor's degrees at various faculties in UNIMAS (Faculty of Social Sciences and Humanities (FSSH), Faculty of Engineering (FE), Faculty of Computer Science and Information Technology (FCSIT), Faculty of Applied and Creative Arts (FACA), Faculty of Cognitive Sciences and Human Development (FCSHD), Faculty of Medicine and Health Sciences (FMHS), Faculty of Resource Science and Technology (FRST), Faculty of Language and Communication (FELC)). Each participant was asked to consent to their voluntary and anonymous involvement in the study. A convenience sampling method was employed for selecting the participants. This study examines the relationship between independent variables digital competencies and digital access and student performance, as illustrated in Figure 2. It is proposed that, i) digital competencies (across the five areas examined) and ii) digital access, including both availability and usage, affect the academic performance of UNIMAS undergraduate students.

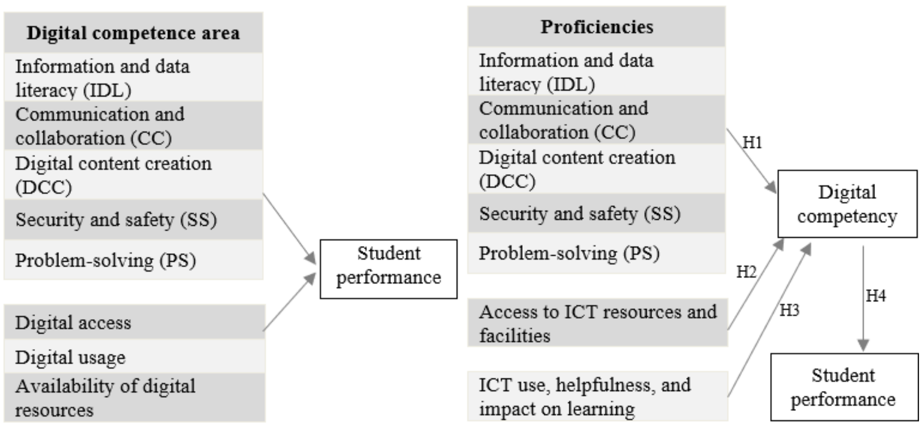

Figure 2. Proposed conceptual research model for assessing UNIMAS undergraduate student digital competence and performance

Since data was collected from a single source, common method bias is utilized by regressing all variables against a common variable are checked. Kock [24], if the variance inflation factor (VIF) is 5.0 or less, bias is not a major concern. Our analysis showed VIF values below 5.0, refer to Table 3, indicating that single-source bias is not significant.

Table 3. Assessment of the latent collinearity results

Constructs	VIF
CC	4.757
DCC	3.559
Availability of digital resources	1.571
Digital usage	1.319
Info and data literacy	3.375
PS	2.363
Safety and security (SS)	2.078

3. RESULTS AND DISCUSSION

The first part of the analysis deals with descriptive statistics (demographical information of the respondents) followed by structural equation modelling (PLS-SEM), which comprises measurement model assessment and assessment of the structural model. The demographic features examined in this study comprised academic grade (CGPA), age, faculty, gender, living area, and level of study, refer to Table 4. Most of the students have CGPAs above 2.50 points (97.7%). Most of the respondents are female (70.6%), and 96.3% are aged between 20-25 years old in different faculty and year of studies at UNIMAS. The study also reveals that 58.7% of the respondents live in an urban setting where they have easy access to ICT tools and services. In addition, 47.7% have more than six years of experience with computers and other ICT tools, and the standard ICT devices students have access to include computers and smartphone devices, with more than 90% of the students having access to either or both.

Table 4. Demographical information of the respondents

Item	Details	Frequency	Percentages (%)
Gender	Female	154	70.6
	Male	64	29.4
Age	19 years and below	1	0.5
	20-25 years	210	96.3
	26-29 years	6	2.8
	40-44 years	1	0.5
Year of study	Year 1	66	30.3
	Year 2	85	39.0
	Year 3	44	20.2
	Year 4	23	10.6
Faculty	FSSH	27	12.4
	FE	2	0.9
	FCSIT	62	28.4
	FACA	86	39.4
	FCSHD	17	7.8
	FMHS	3	1.4
	FRST	3	1.4
	FELC	18	8.3
Grade	2.00-2.49 points	5	2.3
	2.50-2.99 points	58	26.6
	3.00-3.49 points	102	46.8
	Above 3.50 points	53	24.3
Living area	Rural area	128	8.7
	Urban area	90	41.3

Regarding respondents' proficiency level and digital competence, most students have adequate ICT skills, as indicated in Table 5. Specifically, more than 50% of the respondents have at least advanced skills in the five digital competent areas investigated. As supported by [25] DC areas are more essential to student academic performance than others, and students need different types and levels of digital competence at varying stages of their learning journey

At such a proficiency level 'Table 5', the students can guide others and direct ICT use according to their need to solve complex tasks [10] and this aligns with the study by Hasin and Nasir [26]. UNIMAS undergraduate students are digitally competent in the above-tested DC areas. The reason is that the majority (>80%) have good proficiency in the English language, and the majority also (>70%) have been using different ICT equipment, such as computers, for more than four years and above. Similar results are indicated by studies that have investigated factors that contribute to or impact student DC [27]–[32]. Analysis of the multicollinearity among variables of the hypothesized model indicated that the VIF values for all indicators of the latent variables are smaller than 5.0. Table 3 shows that multicollinearity does not exist among the indicators; thus, the indicators are appropriate to be included in the hypothesized model for further analysis.

Table 5. Digital competency level of UNIMAS undergraduate students

No	Digital competence area	Student proficiency					
		Foundation		Intermediate		Advance	
		F	%	F	%	F	%
1	IDL	2	0.9	87	39.9	129	59.2
2	CC	5	2.3	87	39.9	126	57.8
3	DCC	1	0.5	70	32.1	147	67.4
4	SS	4	1.8	86	39.5	128	58.7
5	PS	6	2.8	106	48.6	106	48.6

Table 6 shows the result of the measurement model indicating measurement items were valid and reliable. For the convergent validity, Cronbach's Alpha (α) and composite reliability (CR) of 0.7 and above are needed to accept the model's inner loadings [33]. The outer loadings are required at least 0.5 for each item to be considered reliable [34], [35]. It was discovered that out of 64 items, 18 were deleted because they presented loadings below the threshold of 0.40. Hence, only 46 items were retained in the model as they had loadings between 0.711 and 0.926, as shown in Table 6. The CR coefficient of each latent construct ranged from 0.826 to 0.929, with each exceeding the minimum acceptable level of 0.70 [35], suggesting adequate internal consistency reliability of the measures used in this study. The AVE values exhibited high loadings (>.50) on their respective constructs (i.e., between 0.578-0.725), indicating adequate convergent validity. All items have fulfilled the rule of thumb as recommended by the previous studies. The discriminant validity was also tested [36]. It is the extent to which a latent variable differs from other latent variables. The values of the average variances extracted range between 0.513 and 0.726, suggesting acceptable values.

Table 6. Summary of the measurement model results

Constructs	Items	Loadings, α	roh_A	CR	AVE
CC	CC1	0.835	0.878	0.901	0.647
	CC2	0.715			
	CC3	0.786			
	CC4	0.849			
	CC5	0.829			
DCC	DCC1	0.770	0.851	0.894	0.628
	DCC2	0.850			
	DCC3	0.738			
	DCC4	0.798			
	DCC5	0.800			
ICT resources & facilities (IRF)	IFR10	0.744	0.742	0.826	0.705
	IFR9	0.926			
Digital use	ICT4	0.845	0.882	0.908	0.621
	ICT5	0.795			
	ICT6	0.725			
	ICT1	0.755			
	ICT9	0.797			
	ICT8	0.806			
Digital competence (Dig_Comp)	ICTCOM10	0.783	0.905	0.921	0.596
	ICTCOM11	0.712			
	ICTCOM12	0.825			
	ICTCOM2	0.723			
	ICTCOM4	0.703			
	ICTCOM6	0.791			
	ICTCOM7	0.757			
	ICTCOM9	0.866			
IDL	IDL1	0.805	0.842	0.894	0.679
	IDL3	0.873			
	IDL4	0.835			
	IDL5	0.779			
PS	PS1	0.78	0.910	0.929	0.725
	PS2	0.809			
	PS3	0.906			
	PS4	0.891			
	PS5	0.865			
SS	SS1	0.792	0.869	0.904	0.653
	SS2	0.830			
	SS3	0.800			
	SS4	0.791			
	SS5	0.828			
Student's performance (SP)	SP1	0.711	0.861	0.891	0.578
	SP2	0.750			
	SP3	0.810			
	SP5	0.710			
	SP8	0.830			
	SP9	0.743			

Table 7 shows the correlations among the latent constructs were compared with the square root of the average variances extracted. It also indicates that the square root of the average variances extracted were all greater than the correlations among latent constructs. Table 8 presents the model's heterotrait-monotrait ratio (HTMT) results, with all loadings well below the 0.85 threshold, and the highest ratio being 0.695 for proficiency to students' performance. The validity analysis results suggest that the indicators are appropriate for measuring the variables. Conversely, the reliability analysis confirms that the latent variables are dependable for measurement purposes. The measurement model has also achieved discriminant validity in terms of cross-loading and HTMT, indicating that the constructs are perceived as distinct by the respondents. Overall, these validity tests demonstrate that the measurement items are both valid and reliable.

Table 7. Discriminant validity (Fornell and Larcker [36] criterion)

Constructs	CC	DCC	IRF	Digital use	Dig_Comp	IDL	PS	SS	SP
CC	0.804								
DCC	0.800	0.792							
IRF	0.539	0.49	0.840						
Digital use	0.415	0.375	0.39	0.788					
Dig_Comp	0.472	0.484	0.375	0.646	0.772				
IDL	0.726	0.729	0.491	0.392	0.479	0.824			
PS	0.687	0.713	0.480	0.265	0.424	0.639	0.852		
SS	0.651	0.656	0.462	0.209	0.416	0.61	0.611	0.808	
SP	0.478	0.451	0.45	0.457	0.693	0.448	0.341	0.487	0.760

Table 8. Discriminant validity HTMT

Constructs	CC	DCC	IRF	Digital use	Dig_Comp	IDL	PS	SS	SP
CC									
DCC	0.839								
IRF	0.718	0.646							
Digital use	0.478	0.436	0.500						
Dig_Comp	0.529	0.554	0.477	0.722					
IDL	0.758	0.833	0.658	0.454	0.549				
PS	0.772	0.815	0.611	0.301	0.468	0.730			
SS	0.736	0.759	0.616	0.236	0.470	0.713	0.681		
SP	0.540	0.527	0.639	0.502	0.769	0.525	0.383	0.577	

In this study, multivariate skewness and kurtosis were assessed, revealing that the data were not multivariate normal, as indicated by Mardia's multivariate skewness (β=5.115, $p<0.01$) and Mardia's multivariate kurtosis (β=2.566, $p<0.01$). Following the recommendations of [37], the path coefficients, standard errors, t-values, and p-values for the structural model were reported, based on a 10,000-sample bootstrap resampling procedure. Hahn and Ang [38] suggest that relying solely on p-values is inadequate for assessing hypothesis significance, recommending instead a combination of p-values, confidence intervals, and effect sizes for a more thorough evaluation. The structural model illustrates the relationships among the investigated latent variables, with four principal coefficients used for interpretation: path coefficient (β), coefficient of determination (R^2), effect size (f^2), and Stone-Geisser's value (Q^2) [39].

The result of the hypothesis testing is shown in Table 9. The first relationship tested was for the 7 predictors' effect on students' digital competence, and then the impact of students' digital competence on academic performance. Analysis results indicate that four of the seven predictors had a statistically significant direct correlation with Digital competence (H1a, H1d, H1e, and H3). Also, H4 exhibits a statistically significant direct relationship. Whereas, H1b, H1c, and H2 are not significant factors for student digital competence since there is no relationship between CC, DCC, and IRF with Digital_Comp. Thus, H1b H1c H2 are not supported and H1a, H1d, H1e, and H3 were supported. These four predictors explained a total of 0.521 % of the variance in the students' digital competence. Table 9 shows the estimates for the entire structural model.

Table 9. Structural model

Hypotheses (Relationship)	Beta	Std error	t-value	p-values	Decision	Remarks
(H1a)=IDL -> Dig_Comp	0.190	0.085	2.320	0.044	Supported	RO-1 – proficiency. H1a
(H1b)=CC -> Dig_Comp	-0.114	0.113	1.016	0.154	Not supported	RO-1 – proficiency. H1b
(H1c)=DCC -> Dig_Comp	0.095	0.116	0.818	0.179	Not supported	RO-1 – proficiency. H1c
(H1d)=SS -> Dig_Comp	0.184	0.069	2.666	0.005	Supported	RO-1 – proficiency. H1d
(H1e)=PS -> Dig_Comp	0.202	0.089	2.274	0.012	Supported	RO-1 – proficiency. H1e
(H2)=IRF -> Dig_Comp	-0.020	0.065	0.310	0.373	Not supported	RO-1 – H2
(H3)=Digital_Usage -> Dig_Comp	0.553	0.055	9.988	0.000	Supported	RO-1 – H3
(H4)=Dig_Comp -> Student Perform	0.693	0.038	18.231	0.000	Supported	RO-2 – H4

The H4 which examined the relationship between digital competence and students' performance shows a positive and significant relationship between digital competence and students' performance (β=0.693; t-value=18.231; p<0.01). Thus, the study can conclude that 'digital competence' is a good and significant predictor for student performance.
The regression model derived from this study is as follows:

$$Dig\_Comp = (IDL\ 0.190) + (SS\ 0.184) + (PS\ 0.202) + (Digital\_Usage\ 0.553) \tag{1}$$

$$R2 = 0.521 - Coefficient\ of\ determination \tag{2}$$

$$Students'\ Performance = 0.693\ Digital\ Competency \tag{3}$$

$$R2 = 0.486 - Coefficient\ of\ determination \tag{4}$$

in (1) shows that all 4 predictors explained 52.1% of the variance in digital competence and (4) indicates that digital competence explains 48.6% of the variance in student performance.

For additional analysis, the effect of the predictors on student performance was examined, revealing that digital usage and digital competence exhibit a large effect size. On the other hand, IDL, CC, and DCC have small effect sizes, and the other constructs have no effect sizes. The value was used to understand the effect size of each hypothesis. The value was employed to view the combined effect of the entire constructs, as indicated by (2) and (4). The digital competence (2) and student performance (4) paths have an R2 value of 0.521 and 0.486, respectively, which implies that the four significant factors in (1) influence 52.1% of student digital competence (R2=0.521). This means that 52.1% of students' digital competencies are due to their IDL, SS, PS, and digital usage. Among these four significant factors, Digital usage has a slightly more prominent influence on students' digital competence, refer (1). On the other hand, (3) shows that 'digital competence' has a large and significant influence on 'student performance', which implies that the digital competence of students influences 48.6% of student performance (R2=0.486). Therefore, this study can conclude that 48.6% of student performance is due to their digital competence.

Concerning whether the model can be applied to the subjects in the study population, the model was tested with Q2 values to determine whether the model has any predictive relevance [37]. The result indicates that predictive relevance is demonstrated for the latent dependent variables digital competence and student performance (Q2=0.297 and 0.261), respectively, which means the model can be applied to the entire UNIMAS undergraduate population of this study (N=12,249) to enhance student digital competence and student performance.

The study's analysis result shows that IDL, SS, PS, and Digital usage are essential in enhancing the digital competence of students in the study population. However, the study rejects the hypothesis that CC, DCC, and IFR are significant factors for students' digital competence. Subsequently, Digital competence enhances (significant positive influence) student performance. Our findings extend additional support and are consistent with existing literature on the positive link between students' digital competence and academic performance [40]–[42]. Rodríguez *et al.* [43] reported that digital competency influences 30.5% of the academic performance of university students, while this work reports that students' digital competence influences 48.6% of student performance. This suggests that, according to the current research, digital competency has a stronger effect on student performance than previously documented. More emphasis should be on factors that also help students build their digital competence.

In conclusion, the model used in the study showed significant predictive relevance for the entire population, indicating that its findings can be effectively applied to improve digital competence and academic performance among undergraduate students. Additionally, the study identifies key proficiencies most closely linked with digital competence, contributing valuable insights into its impact on academic performance. This information is useful for educators and policymakers seeking to enhance teaching and learning practices by developing digital skills

4. CONCLUSION

European Commission's recognition of digital competence as one of the eight core competencies for lifelong learning makes DC essential to our everyday lives, particularly students' academic journeys. Existing literature has shown mixed results regarding the impact of ICT on student achievement, and the effectiveness of technology in education requires a solid understanding and confidence, regardless of how advanced the technology may be. It is necessary to assess the degree of digital competence of students since the usage of digital resources is more important than the quantity and quality of technology available. Student competence in using ICT is a critical component in delivering ICT's impact on education. When students possess the appropriate digital competence, they are better able to access and utilize digital resources to assist their learning, which can result in enhanced academic performance.

This study used a two-step process to evaluate and report the results of the PLS-SEM path, including assessing the measurement model and the structural model. The study found adequate convergent and discriminant validity and adequate internal consistency reliability of the measures used. The indicators are valid for measuring variables, and the latent variables are reliable for measuring variables. The analysis reveals that five constructs showed a significant positive relationship between digital competence and student performance out of the eight hypotheses tested. Additionally, among the seven constructs evaluated to identify the digital skills needed by undergraduates, the use of digital tools was found to be the most influential factor. This suggests that simply having access to digital resources and facilities does not guarantee improved digital competence; rather, how students actively use these tools is crucial for enhancing their digital skills. The study also confirms a significant positive correlation between student digital competence and academic performance, consistent with previous research.

Moreover, digital competency not only boosts academic performance but also helps students develop essential 21st-century skills such as critical thinking, PS, CC, which are increasingly valuable in today's society and careers. However, it is important to note that digital competency alone does not guarantee academic success; resource availability also plays a crucial role in influencing academic achievement. Future studies can explore developing a contextual DC framework that can be implemented and validated based on the localized digital needs of the environment to match with the level of digital development and infrastructure available.

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Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, [AOV]. The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions.

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